Technical User Guide for IHI's Fine Stranded FLEX (Flexible) Wire & Cable Lugs and Splicer Reducers

Now UL & Canada Approved for FLEX Wire From #14 to 444 kcmil / MCM (see individual lugs user labels for details).

Selected IHI Connectors® brand Listed Lugs and Splicer-Reducers are now UL Listed and Canada Certified for use with Fine Stranded Copper FLEX cables as well as Conventional Rigid Stranded Wire Classes B / C / Compact in copper and aluminum. Look for "FLEX" designation on individual IHI Connectors® brand lugs.

Q. Do I have to buy lugs that are UL rated for the fine stranded classes that I want to use? Flex wire has been used for years with standard lugs so why all the fuss?

A. Yes, UL and NEMA and NEC have made it completely clear that use of any wire connector that is only rated with UL486A-B is NOT adequate since this BASE standard does not automatically cover wires outside of standing classes B and C, the so called "rigid stranded" classes. Only wire classes in the base standard are tested by UL and other NRTL's unless the scope of the testing is widened with an additional testing plan, for the other wire classes.

So ONLY wire lugs that have been specifically designed and tested to work with fine stranded wires AND specify the fine wire classes and sizes in the product labeling, are allowed to be installed in panels or other UL / NEMA / NEC controlled electrical installations.

LugsDirect.com sells IHI Connectors® brand "FLEX" tested lugs which are approved, after extensive current/thermal and mechanical testing under UL486A-B /C22.2 No. 65.

Q. Where does it say that I cannot use stranded wire other than B and C stranded classes?

A. In UL486A-B (Canada C22.2 No 65) it lists the wires that ARE covered by the base standard. These are shown in this link

UL has published this document that clarifies their policy that only FLEX rated wire connectors may be used, at this link:

UL508A: The standard for Industrial Control Panels is said by UL to be "The premier standard for designing and constructing for compliance with the National Electrical Code."

UL508A states:
29.2.1, "Machine tool wire that complies with the standard for Machine-Tool Wire and Cables, UL 1063. Flexing or Class K type machine tool wires and cables shall be installed in accordance with 29.3.11;" and "Welding cable installed in accordance with 29.3.11."

29.3.11, "Flexible conductors, including welding cable and machine tool wire identified as "Flexing" or "Class K", shall be retained by terminals that have been evaluated to the

standard for Wire Connectors, UL 486A-486B for the size and type of conductors involved."

" e) (solid and stranded) metric wire falling within the ranges of the above AWG sizes. Note: For example, a connector rated for 6 AWG – 250 kcmil may be additionally rated for 16 – 120mm2.
f) Other class and strand configurations as indicated by marking"

7.1.7, "A connector rated for Class 5 and 6 metric conductors (flexible stranded) shall be subjected to all test sequences using flexible metric conductors."

NEMA has also published a bulletin to clarify this policy at this link:

NEC Section 110.14 of the 2011 code requires that all connectors for fine stranded wires be identified for the specific conductor class or classes (such as stranding class G, H, I, K and associated numbers of wires in each size of cable).

Q. Lugs all look the same, what is different about a mechanical lug that has been rated for flex wire?

A. The aspects of a lug and wire binding screw design that are important for use with flex wire are trade secrets within a given manufacturer. Among other considerations, the design for flex wire involve the right combination of geometry, symmetry, and finish of the screw nose and wire hole base machining geometry and the screw thread pitch, screw torque and screw lubricant technology. Extensive work is done in testing, to find the right balance between needs for adequate wire secureness and freedom from unwanted levels of wire deformation or damage.

Q. Can I just use a crimp-on "solid pin adapter connector" in a lug wire hole that is not rated for flex wire?

A. Usually no. Unless A) the CRIMP portion of the "pin adapter" is rated for wire of the size and class of fine stranded you are working with, and B) if the PIN portion of the pin adapter is actually a coarse stranded class B or C wire, not a solid pin.
Click here to veiw UL/Canada Approved Flex Wire Pin Adapters

Pin connector" are combination crimp tube type compression connector/adapter with either a serrated SOLID copper pin on the end of it, or a STRANDED wire "pin".

The "pin" goes in the mechanical connector wire hole in place of a real stranded wire of B or C class, to adapt a wire which is too large a diameter to fit, as typically occurs with fine stranded wires or oversized wires chosen to reduce volt drops on long runs.

Be sure to choose adapter pins with the correct standard stranded wire since solid pins

are NOT part of standard UL486 wire scope, since UL486 default solid wires are typically limited to 10 AWG and smaller.
There is a good reason for a solid copper (or aluminum) pin not being a default approved substitute for a large stranded wire. The screw of a mechanical connector will not penetrate into a solid pin in the same way it does for a stranded wire, so pull out performance may be compromised with uncertain results (unless tested to UL486). In any case, if UL has not already tested and approved the lug or mechanical connector that you are using for a solid wire of similar size and class of conductor to the solid pin the combination is not default approved.

It is not commonplace that UL486 Listed Lugs are rated for large diameter SOLID pins/wires of any type. A pin is not a class B or C stranded wire and therefore is not approved by default. Unless a lug manufacturer can show you the UL approval in terms of a large solid wire or pin, of the specific gauge you want to use, then you can assume the lug is not rated for it.

When using a pin connector with an increased diameter crimp tube there is an increased chance that pole to pole spacing may be reduced below the minimum required depending on the voltage so be careful to consider the metal parts outside of the lug.

Q. What ranges of flexible wire can be used with the IHI Connectors® brand lugs?

A. Copper fine stranded class G, class H, (aka battery cables) class I / type DLO (aka Diesel Locomotive) / class 5 metric (mm2) (aka "f") and class K (aka "MTW" Machine Tool Wire, Welding Cable). Note that names like "battery cable", "welding cable", etc. are not good indicators of the actual stranding class. It is necessary to know the actual stranding class before mounting any wire.

Insulation voltages, insulation heat ratings and insulation resistance to environmental contaminants also need to be considered for the application and codes but are not otherwise restricted by the the lug's fine wire rating approvals.

Q. The flexible wires are larger than standard rigid stranded classes for the same wire gauge, so does that affect the capacity of the lugs?

A. Yes. Generally you will need to go up one size to be able to accommodate a flex wire of the same maximum gauge. Each lug rated for flex wire will have the maximum and minimum size (gauge) of wire that can be used. Look on the labeling that comes with the "FLEX" lugs to see what size range is available for flexible fine stranded wires and the respective torque to use on the wire binding screw for that wire.

Q. Do the mechanical lugs that are rated for fine stranded wires have the ability to cover a wide range of flex wire sizes?

A. Yes. Though the gauge range is smaller than with rigid stranded wires and cables, the Flex lugs are still able to cover a good range of different gauges in the same lug. This enables one wire connector to be applied to different current applications and meet last minute customer wiring class preferences.

Q. Are the strandings standardized, based on the class letter, from one cable manufacturer to another?

COARSER -------**class B / mm2 "r"class 2 > C > G > H > I /mm2"f" class 5 / DLO > K** > M ------- FINER
Sizes in bold are covered range in IHI FLEX lugs. Metric class 2 is like Class B and Metric class 5 is like class I. View Wire Stranding Class by Class of Wire here.

A. Yes, pretty much. However there are small variations in stranding count between manufacturers who have to focus on the gauge (cross sectional area) first, since that is what carries the current. So small variations in the single strand size can lead to increases and decreases in strand count. None of this make any difference of consequence.

Metric rigid stranding class 2 is similar to AWG rigid stranding class B.

DLO fine stranded is similar to I stranding class and so is metric class 5 fine stranded.

The gauges vary between METRIC mm^2 nominal sizes and AWG nominal sizes since many fall between each other's sizes rather than happen to match up. Still the character of the wire in a similar cross sectional size, stranding class, and alloy, is substantially the same.

UL486 covers Metric sizes that fall between tested and rated wire ranges in AWG /kcmil sizes that share the same wire binding torque but not sizes that fall outside of the tested ranges.

Q. Does wire always have the stranding class printed on it?

A. Alas, no. However, the wire gauge is "always" on the wire insulation and the size of a single strand can be easily measured with a good pair of calipers or better, a micrometer. Check several strands to be sure you have the right diameter.

Using a suitable wire chart with the classes and number of strands, and the diameter of the strands, in columns, it will become clear which class it is. Counting strands on fine wire is not the quickest way to verify the class but is always the best if there is any confusion. Single strand diameters are often shown in AWG themselves so, for example, a K class strand is .010" diameter but may be listed as 30AWG - the same thing.

Q. I get that the deeper into the alphabet you go, the finer the wire stranding is for a certain gauge. But how do I choose the right FLEX cable to use?

A. The most popular and most widely available flex wires in North America are probably the class I / DLO types and the class K types (Machine Tool Wire) depending on end user and industry type. G, H are also used but less popular and less readily available.

In the Metric countries, class 5 (mm2) FLEX wire is popular and can be grouped with the class I / DLO stranding even though it has different gauges and current ampacities.

There are finer stranding classes than these approved ones, but are designed for moving wire applications and therefore are outside of the scope of stationary, static, wire connections covered here.

Both FLEX groups (I /DLO /Class 5, and Class K) are easily bent to tight bend radii and easily routed in tight space panels and spaces.

Class K, is a very flexible wire and feels "floppy". It tends not to retain a bend or a 'set'. It has strands which are only .01" (.254mm) in diameter (30 AWG each) in all gauges of cable. There are disadvantages to really fine wires, having strands that are only about 3 times thicker than human hair.

More care has to be taken by installers to ensure proper terminations and manage the weight of the wire. It is logical that class K wire will need more tie down than a more rigid wire and will generally have a lower SCCR (Short Circuit Current Rating) performance than more rigid wire due to its floppiness and fine "fuse wire like" stranding.

Class I / DLO / metric class 5 are similar in strand diameters and approximate number of strands for a similar gauge and can be considered as a group as far as the conductor stranding is concerned.

This group is also readily bent manually but not so "floppy" and does hold a 'set' when bent. It take more force to bend it but can still be done without pipe benders. The stranding sizes are coarser than class K which makes them easy to control when stripping, and while inserting stripped wire into the lug wire holes.

Metric mm2 class 5, and DLO have some gauge differences from standard AWG/kcmil gauges which can be useful when looking for in between sizes of kcmil or for wiring in countries outside of North America. Metric wire is in round numbers of mm2 (millimeter squared cross sectional area) so naturally does not line up with AWG / kcmil sizes based on the AWG formula or circular mils, the area of a circle .001 inch in diameter. DLO differs from AWG /kcmil gauges in the larger sizes.

A Rule of Thumb for converting metric to kcmil : The mm^2 number is about 1/2 the kcmil/MCM number).

Q. In terms of reliability which type or class of wire at is the most robust in long term use?

A. That is a deep questions and can never be fully answered without an understanding of every aspect of an application including environmental factors, but as a generalization the list below gives some insights.

All of the wires listed for IHI lugs that are approved and have passed the requirements of UL486 Dual Rated, Copper and Aluminum, coarse/ RIGID and fine/ FLEX stranded and compacted strand RIGID.

The order of robustness for different wires, materials, and stranding types is a debate that will never be settled since every application and implementation has its own idiosyncrasies and priorities. Aluminum and copper wire manufacturers market their respective products and offer compelling studies to show that, implemented correctly, excellent results are obtainable.

Nevertheless, some generalized comments may be made for the sake of getting some perspective as to the engineering trade offs that are made when "easily bent" wire is specified for ease of installation.

If ease of bending and cost of metals were not factors in wire choice at all, but only the best overall performance and reliability under most conditions, the following order of preference might be agreed by many.

#1. Copper Rigid stranded wire classes B /C are often considered to be the most stable (but also the hardest to work with in larger sizes due to the stiffness and need to use pipe benders to form the larger cables).
40+ years of solid history of use in tin plated aluminum lugs. US industry has been built on this wire / lug combination. The ampacity (rated current) of copper is higher than for the same gauge of aluminum wire.

#2. Aluminum Rigid stranded wire classes B /C are considered to be more challenging since they need to be prepped for oxide prevention on the strands. The use of oxidation removal and special air barrier "grease" is recommended by aluminum wire and cable makers. Lug makers do not argue with that logic. Standard rigid stranded class B / C aluminum cable is widely used and is very compelling for lower cost on long runs where installers know how to do it right. Aluminum wire has an advantage when mounted in all aluminum lugs (body and screw made of aluminum - the common format for larger wire Dual Rated lugs). The reason being that both wire and lug expand and contract at the same rate which tends to maintain the correct force balance under a wide range of operating temperatures.

#3. Copper Compact, a rigid stranded copper cable with a much smaller diameter under the insulation which reduces heat dissipation so tend to run hotter. The coarse strands are still considered stable and do not offer much of a challenge for properly designed and tested lugs. Used in tight routing locations like certain types of armored cable. More common in Canada.

#4. Copper moderately FLEX wires - Class I / DLO / Metric class 5. Not a huge leap from copper rigid stranding. DLO has been around for as long as the Diesel-Electric Locomotive. DLO has tinned wires which minimizes strand oxidation. Class I and Metric class 5 are in the same group and widely accepted. Historically used widely in tin plated aluminum lugs before the new "test the flex" rules came out in UL standards UL486 / UL508A etc. This class Standardized in some high end Automotive panel standards for reliability.

#5. Copper fully FLEX wires - Class K, Welding wire, MTW, similarly stranded battery wire. K flex wire is so fine, that in the larger sizes, it has a very noticeable "bulked up" diameter even with the insulation on it. After the insulation is removed it fluffs up some more. In the smaller sizes class K appears quite normal looking wire common Machine Tools "hook up" wire.

The fixed .01" diameter wire strand size makes it look balanced in smaller gauges and it behaves well. In the larger gauges with the same .01" strands is where is starts to look like "ship rope" and feels like it too. Heavy, floppy and very flexible, it does start to become more challenging to prepare and implement in wire holes of connectors and perhaps to stabilize it for SCCR.

In spite of the large physical size, this wire has become very popular for fast wiring of compact panels in the last decade or so, and there appears to be few problems even BEFORE the lugs used had to be tested and approved for flex wires. Bear in mind UL508/A panels standard mandates 75C temperature (lower) current ratings rather than 90C and are mostly in favorable ambient temperatures, indoors.

IHI FLEX RATED lugs are all "oversized" for the approved flex wires in that the current carried by the all of the flex wires is lower than the lugs nominal maximum current rating. Flex cable, being *smaller* in actual gauge and *larger* in diameter) than the maximum B/C/Compact cables.

This is a comfort in terms of the higher amount of lug metal for all flex wires per amp connected. IHI's FLEX lugs have passed heat rise testing at UL as well as mechanical sequence testing. When using a larger physical size fine stranded wire there are two plusses for cooler running.

1. The smaller than maximum lug capacity gauge wire means that the lug is not being run at its full "wire rated" current.

2. The larger physical diameter of the fine stranded wire creates a higher wire to air

cooling factor versus a smaller diameter coarse stranded wire due to increased surface area.

More new applications like PV often require 90C and may involve unusual extremes of daily temperature. On the other hand there is no large SSCR potential current spikes from solar panels.

#6. Aluminum Compact cables are considered to be the toughest test for UL486 connectors since their diameter is the smallest per given gauge, having the strands (rigid stranding) compacted down by cold rolling until there is little space left between strands. This creates an almost "solid" wire appearance. While currents are reduced for aluminum wire to compensate for the higher heat generated (IACs ~50%) created for a given size of wire, larger gauges can be used to overcome the lower current ratings per gauge assuming a larger lug is also used. Aluminum is 1/9th of the *cost per cubic inch* versus copper so economics easily allow bulking up. A larger diameter cable of aluminum, carrying the same current of a smaller copper cable has more cooling area on the surface and can compensate for higher resistance of the aluminum cable (voltage drop) compared to the same class of smaller gauge copper cable.

Still, this type of aluminum compact cable may also made in the soft alloy 1350 which is the toughest test connection for UL486 testing since it is soft and prone to creep under load.

Newer, 8000 alloy wire is used much more commonly outside of the utility industry. This harder, more copper like alloy in terms of creep resistance has made aluminum a more robust format for all compression lugs.
Since UL486 has to take the worst case alloy (1350) to test the 500 cycle on-off, over-current, stress test, all other wires are considered to be easier to terminate than compact aluminum alloy 1350 and therefore may provide some comfort in terms of use of flex copper wires and the comparative plusses and minuses..
SUPERFLEX / HIFLEX wires:

Flex class M and Metric mm2 Class 6 are so fine as to be unsuitable for standard compression connectors.
IHI Flex lugs are NOT suitable for this type of wire and should never be used.

Q. If certain IHI lugs have been tested to UL486A-B for fine stranded wire does that mean I can have always have complete confidence in them working my application, no matter what?

A. No. Definitely not. Applications vary so much that only complete and thorough customer testing can prove out the reliability and longevity of fine stranded wire connections in the specific application. The pace of development of solar PV wiring, for one example, is stretching the limits the traditional electrical standard worldwide and new proposals are

emerging constantly to deal with new innovations and real world economics to reduce cost per useful Watt.

UL testing performs rigorous standardized tests - but it does not mean that every application that uses UL tested parts is an automatic success. You should have more confidence in lugs that have been tested by an NRTL and approved for the finer stranded wire, compared to lugs that have not been tested and approved. In addition, you have the needed agency approval to use the fine stranded wire in these lugs in a UL/Canada application.

So, neither UL, Canada, any other NRTL, or IHI, guarantees that having passed the standard tests, the parts are suitable for your particular application. The maker of the panel or electrical apparatus has to test as an assembly under the most arduous conditions that might be encountered. Long term reliability "stress" testing under harsh environmental conditions are mandatory for developing likely failure mode analysis and correcting the shortcoming before field installations are in place.

Q. Can multiple wires of fine stranded wire be used with IHI lugs?

A. No but there are also new IHI multiple wire lugs which enable dual wires of stranding class B and C wires to be mounted in one wire hole. Dual multiple wire capability is available for 2X #14 AWG to 2X #2 AWG class B / C.
When using fine stranded wires and cables one wire per hole is permitted.

Twin ferrules may be used for 2 FLEX wire if rated for it on the user label.

Q. Should I use anti-oxidation compound on copper flex wires like is recommended by aluminum wire manufacturers?

A. Anti-oxidation is not normally used on copper wire since copper has a much slower build up of oxide than aluminum does and it does not become much of a conductive issue until the copper is looking fairly tarnished. Tarnished copper wire and tarnished fine stranded copper wire especially should never be used to make a wire connection.

Using freshly stripped copper or discarding ends of wire that has been stored for a long time is important to ensure a bright copper stranding to make a new gas tight wire termination joint that is not compromised with undue strand tarnish built in.

It is apparent that with the finest of wires, like class K there is hugely increased surface area of copper strands compared to coarser strandings of the same gauge. The contact pressure and gas tightness between the strands is important to maintain the voltage drop from joint resistance over time. Depending on the conditions under which the termination will operate, the use of a suitable long life wire anti-oxidation compound may be justified.

"**Conductor termination compound** — Some wire-connector adapters are shipped pre-filled with conductor termination compound (antioxidant compound). For non-prefilled wire-connector adapters, conductor termination compound may be used if recommended by the wire-connector adapter manufacturer as preliminary preparation of the conductor. Wire brushing of the conductor may also be performed if recommended. Also see Conductor Termination Compounds (DVYW)."

Ref. UL White Book ZMVV section

Q. How should I prepare a wire for insertion into a FLEX lug?

A. Proper preparation of fine stranded wire with particular emphasis on class K / welding / battery cable and Machine Tool Wire is more demanding than with coarse stranded wire due to the finer strands needing to be controlled.

1. Cut off the wire CLEAN & SQUARE and with no loose and straggling strands.

2. Ensure that NO fine strands are cut when taking off the insulation using an appropriate insulation cutting procedure. Cutting part way through with a depth limiting insulation cutter, then bending to complete the tear is one way to avoid touching the wire with a knife blade.

3. Open up the lug screw fully enough to avoid catching fine strand on any part of the insides of the wire hole.

4. If the flex wire is NEAR TO the maximum capacity of the lug and especially true for type K "hairy" wire, use a wire tie or a turn of electrical tape at the end of the stripped cable to control the strands before and while inserting the wire in the wire hole. Snip off the wire tie or pull the tape out of the rear sight hole before tightening the binding screw.

It is important that 100% of the strands make it through the hole, past the binding screw, to the back end of the wire hole, and do not poke up into the screw hole thread which, if severe, can cause a loss of screw torque from extra binding friction and must be avoided.

This is common practice for properly trained installers and those familiar with using K wire in particular know what matters.

Strands of the less fine FLEX classes I, DLO and Class 5 Metric are much easier to work

with and overall diameter of this medium fine class is not so "bulked up" so do not generally require special measures to control strands in competent hands.

5. ALL flex wires need to be tightened to the screw torque on the label for that gauge of wire and wire class.
Never torque less than the torque on the label.

6. ALL torques must be set using an accurate torque wrench and must be held CONSTANT for FIVE (5) full seconds after the torque is reached. That means torque is applied to the screw and the screw keeps turning until it no longer turns at the rated torque for 5 seconds. This is a UL486 test requirement AND a requirement for all factory and field installs. Again, experienced installers know that that the load on the wire will be as rated only once the CREEP in the wire and lug body has been taken up. This MAXIMIZES the holding spring force on the wire which retains a gas tight contact pattern during heat and cool cycles over time. Take the time to do it right. It matters.

7. Inspect. IHI mechanical lugs are provided with large "sight holes" at the back of the lug so that correct insertion length and free of stray strands.

The UL486 standard allows for 5% cut strands for fine stranded wire under test. IHI lugs screws have a process smoothness and surface treatments to reduce the abrasion of strands to a very low extent. Typically, strands are squashed, not cut and squashed strands are typically retained until the wire is removed.

Class K FLEX wire is the most likely to have strands which could detach, especially if the wire is improperly installed. Using Class I / DLO / Metric class 5 reduces the risks from very fine strands since the strands are larger while maintaining good routing bend radius flexibility.

Q. Can I use TINNED wire?

A. Yes. The UL486 testing was carried out with both tin plated or tin coated wire strands, and bare copper wire. DLO wire for example is typically pre-tinned (individual strands are tin plated prior to making the wire). Do not confuse tinned wire strands with solder dipped wires (whole wire dipped in hot solder).

Q Can I use solder dipped wires?

A. No. Solder dipped wires are not permitted since the solder creeps under pressure from the wire binding screw over a short time, and so contact pressure can be soon lost after torquing to spec.

Q. What about solder dipping the tips of the wire only in order to control the strands on the K wire especially?

A. There are other ways to control the strands during insertion (see "How should I prepare a wire for insertion into a FLEX lug?" above.

Q. If I use a ferrule on flex wire, then may I use any lug to terminate flex wire?

A. No. Using a ferrule does not make any lug "suddenly" rated for flex wire. The lug itself needs to be rated for flex wire to be able to terminate flex wires. IHI FLEX lugs do not require ferrules. They have been tested and rated for bare flexible fine stranded wires, with no ferrules needed.

IHI FLEX lugs are UL Listed for "General Use" and the wire connections themselves do not have to be further evaluated if all associated panel construction is to panel codes and wires are mounted following the labeled torque requirements. Where lugs are used in a non-General way, then the part needs to be evaluated along with any plastic and insulation components as part of a UL rated assembly which typically involves more pull out and heat rise testing in the fully assembled form.

If you choose to use ferrules for some application that is UL controlled you will generally need to to have UL evaluate the final assembly with regard to the combination of wire and ferrule that you are using. To that end, having a ferrule that is already UL486 rated for the specific flexible wire and crimping tool used, can be very helpful.

UL rates ferrules based on the pull out forces in UL486 using a ferrule crimped with the tooling as submitted.
If using a ferrule on fine stranded wire you should check to see if the ferrule is specifically tested and approved for that wire size and stranding class, and check part number of the tooling used to crimp that wire, since it will be necessary to use the same tooling used in the testing.

UL has qualified conditions for use of ferrules on FACTORY wiring which is under professional control. See also below "use of ferrules" policy from UL.

For factory AND FIELD wiring, IHI listed lugs are able to provide wide Ranging Wire Size, Dual Rating for conductor alloy choice and Rigid and FLEX stranding options with NO crimp-on ferrules or specialized crimp tooling of any kind needed.

Q. Do ferrules change the wire range of a wire connector?

A. Yes. Ferrules typically decrease the size capacity of the lug since the wire, with a crimped ferrule takes up a larger inscribed circle than a bare wire. The common trapezoidal and square cross sections are "a square peg in round hole" that may require a

larger lug than otherwise might be necessary. Hexagonal crimp tooling is the best fit for a round hole but be sure you know what tools were used to crimp a ferrule in the manufacturer's UL testing, since it will also need to be used in any subsequent UL covered use of that ferrule.

Ferrules are more commonly used on smaller gauge, lower power, fine stranded wiring for DIN rail type applications.

For larger gauge, higher power wire cabling, the use of ferrules is less common or applicable, but nevertheless, if you want to qualify a ferrule for an IHI FLEX lug you are free to do so under the NRTL assembly testing program having already in hand the qualification of the lug itself for flex wire.

USE OF FERRULES:

The original 2013 published “Use of Ferrules” bulletin from UL found here (historical use only) has been replaced by a formal “UL Decision” on 11-3-2016.

UL has made the following decision on 11-3-2016 for UL508A panel builders with regard to factory wiring use of ferrules:
This information is provided ver batim as an educational convenience to UL508A compliant customers seeking to learn about the ***use of ferrules on fine stranded wire used in combination IHI® brand fine stranded mechanical wire connector lugs, in factory wired situations.*** Check with your UL field inspector for current practices and updates.

Date issued 11-3-2016. Date uploaded to UL site 11-4-2016

UNDERWRITERS LABORATORIES INC. CERTIFICATION REQUIREMENT DECISION
This Certification Requirement Decision is prepared by UL LLC. It is normative for the applicable UL
Product Certification Program(s); however, it is currently not part of the UL Standard(s) referenced
below.
Product Category (CCN): NITW
Standard Number: UL 508A
Standard Title: Standard for Industrial Control Pan(els)

Edition Date: December 20, 2013
Edition Number: 2
Section / Paragraph Reference: Sections 29.3.4, 29.3.5.1 (New), SB3.1 and SB4.2

Subject: Wiring Ferrules for use in Industrial Control Panels

DECISION:
29.3.4 A connection to a terminal of a component shall be made by:
a) Wire inserted directly into a pressure wire terminal of the component;

b) Quick-connect terminal of the component, where the mating part is provided with a dimple,
depression, or spring-type connection such that a mechanical snap-action connection is made
that does not rely solely upon friction between the two parts;
c) Crimped-on pressure terminal connector or closed-loop eyelet;
d) Solder terminal specified in 29.3.2;
e) Wire-binding screw specified in 29.3.3; or
f) Open-type eyelet specified in 29.3.5.
g) Wiring ferrule specified in 29.3.5.1.
29.3.5.1 A wiring ferrule shall be:
a) Used with stranded copper wire(s) only
b) Terminated in a connector rated for copper wire and rated for the number and size of wire(s)
crimped to the ferrule.
c) Crimped with an appropriate tool as recommended by the ferrule manufacturer before terminating in a terminal of a component.
d) Sized in diameter appropriate for the number of wires and wire size(s) as recommended by the ferrule manufacturer.
e) Crimped to the wires such that the length of the uninsulated portion of the wires does not result in the reduction of electrical spacings when the ferrule is installed.

SB3.1 Internal wiring connections

SB3.1.1 All terminals of power circuit wiring connectors, wiring ferrules and components shall be torquedto the manufacturer's specified value or crimped-on according to the manufacturer's instructions

SB4.2 Short circuit current ratings of individual power circuit components

SB4.2.1 All power circuit components, including disconnect switches, branch circuit protective devices,
branch circuit fuseholders, load controllers, motor overload relays, terminal blocks, and bus bars, shall
have a short circuit current rating expressed in amperes or kiloamperes and voltage.
Exception No. 1: Power transformers, reactors, current transformers, dry-type capacitors, resistors,
varistors, and voltmeters are not required to have a short circuit current rating.
Exception No. 2: The ²S² contactor of a wye-delta motor controller is not required to have a short circuit
current rating.
Exception No. 3: Wiring ferrules are not required to have a short circuit current rating, provided that the requirements of 29.3.5.1 are met.

RATIONALE FOR DECISION:

Wiring ferrules are commonly used to facilitate connection of internal wiring in industrial control panels. The use of ferrules is currently not addressed by UL 508A. Ferrules are limited to factory installation since specialized tools and control of their use must be applied to the installation. Any manufacturer's ferrules are suitable for use in factory wiring only, power or control circuits. As ferrules are an extension of a conductor, no short circuit current rating is required or assigned.

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